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# FLORISTICS OF MUCK BOGS IN EAST CENTRAL TEXAS

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## ABSTRACT

We describe the floristics and edaphic conditions of muck bogs in the post oak savanna region of east central Texas. These bogs are floristically different from east Texas hillside seepage bogs.

KEY WORDS: bog, Gus Engeling Wildlife Management Area, *Sarracenia*, post oak savanna, pitcher plant, floristics, Texas

## INTRODUCTION

Recent studies of pitcher plant habitat (bogs) in the West Gulf Coastal Plain (WGCP) have been confined to the piney woods region of east Texas and western Louisiana (Nixon & Ward 1986; Allen *et al.* 1988; MacRoberts & MacRoberts 1988, 1990, 1991, 1992, 1993; Bridges & Orzell 1989a; Harcombe *et al.* 1993). Studies of muck bogs in the post oak savanna region of east central Texas (Rowell 1949a, 1949b; Kral 1955; Lodwick 1975; Starbuck 1984; Bridges & Orzell 1989b) show a type of bog that differs in many respects from more eastern bogs. Among other things, these bogs quake and have a very high organic content and biomass. Analyses of peat deposits at some of these sites (Potzger & Tharp 1943, 1947, 1954; Graham & Heimsch 1960; Larsen *et al.* 1972; Bryant 1977) indicate that bogs with high organic content have been present in east central Texas for thousands of years.

Kral (1955), Rowell (1949a, 1949b), and Lodwick (1975) provide a general description of muck bogs. The bog edge, often up to a meter higher than the bog center, is sandy and has low organic content. During short droughts, the edge may temporarily become dry. The bog flattens toward its center. The soil is completely saturated throughout the year and consists of a thick organic slurry that is kept wet by seepage from surrounding xeric sandhills of higher elevation. The bogs are firm enough to walk on and consist of masses of intertwined roots and rhizomes. The mass of vegetation grows mainly on root hummocks, although some species are floating or anchored in the slurry amongst the hummocks. *Sphagnum* is present and buildup of organic matter is high. Peat depths of over five meters have been measured. In places, the surface quakes, and it is possible to shove a pole two to three meters down with little resistance.

Muck bogs are open and generally treeless, and appear to develop on blocked meander streams. Shrub thickets may develop when fire is excluded. Many muck bogs have pitcher plants and a rich herbaceous layer with an array of carnivorous species, grasses, sedges, and xyrids (Folkerts 1991; Kral 1955; Lodwick 1975; Rowell 1949a, 1949b; Starbuck 1984; Bridges & Orzell 1989b). In the center of the bog, there often is a stream.

The purpose of this paper is to describe muck bogs at Gus Engeling Wildlife Management Area (GEWMA), Anderson County, Texas. It was of interest to us to extend our research on bog communities of the West Gulf Coastal Plain to these post oak savanna bogs and associated marshes. They have been little studied, and most of what has been recorded about them is unpublished (Lodwick 1975; Rowell 1949a; Starbuck 1984).

## STUDY SITES/METHODS

In 1997 and 1998, we conducted a systematic study of the floristics of two muck bogs on the 4436 ha GEWMA, Anderson County, in the post oak savanna region of east central Texas (Telfair 1988; Lodwick 1975; Johnson 1986). The area is gently rolling to hilly and is drained by Catfish Creek, a tributary of the Trinity River. Most of the streams are spring fed and flow year round. The upland soils are rapidly permeable sands (Telfair *et al. n.d.*; Hauke & Rose *n.d.*).

Detailed floristics were done on two bogs: Chester's Bog is on Gibson Branch at the northern end of GEWMA and Andrew's Bog is east of DD Spring, also at the northern end of GEWMA. The two bogs are about 1 km apart. Chester's Bog is down stream from an artificial lake, which has undoubtedly affected its history by altering its hydrology. Andrew's Bog is not affected by any artificial impoundment or any man-altered drainage.

Surveys were conducted on a monthly basis, except for the midwinter months. From July 1997 to July 1998, each bog was surveyed ten times. The northern edge of Andrew's Bog was surveyed at two sites totaling about 3 ha. An area of about 2 ha of Chester's Bog was surveyed.

We follow Kartesz (1994) for nomenclature in most cases, but see Jones *et al.* (1997) and Nesom (1994).

Soil samples were analyzed by A & L Laboratories, Memphis, Tennessee. Because the organic matter was so high, we ran a "manure" analysis on one sample to compare results (see A & L Analytical Services List for procedures).

The early fire history of these bogs is unknown. Chester's Bog was burned in early 1990; the precise month is not known. It was badly overgrown with shrubs and was hand cleared in the summer of 1995. Andrew's Bog was burned sometime in 1980 and in February 1985, 1994, 1996, and 1998.

For east Texas, precipitation is generally uniformly distributed throughout the year, averaging about 100 cm. Summers are long and hot; temperatures rise to 35° C, which, combined with short droughts, translates into dry conditions with streams sometimes drying up: 1998 was a drought year. Winters are mild with few days of freezing weather (typically about 268 frost-free days). Mean annual temperature is about 20° C, with an average January temperature of 7° C and average July temperature of 27° C.

## RESULTS

Table 1 lists the vascular plants found in Chester's and Andrew's bogs. (A = present in Andrew's Bog, C = present in Chester's Bog: number in brackets is our collection number. No number indicates no collection. Specimens will be deposited at VDB-BRIT and TEX.)

Table 1. Plants of Chester's (C) and Andrew's (A) bogs. Numbers refer to MacRoberts & MacRoberts collection numbers.

SPHAGNACEAE
*Sphagnum* [A, C]

BLECHNACEAE
*Woodwardia areolata* (L.) T. Moore [A, C *3581*]
*W. virginica* (L.) Sm. [A]

LYCOPODIACEAE
*Lycopodiella appressa* (Chapm.) Cranfill [A *3979*, C *3694*]

OSMUNDACEAE
*Osmunda cinnamomea* L. [A, C]
*O. regalis* L. [A, C]

SELAGINELLACEAE
*Selaginella apoda* (L.) Fern. [C *3775*]

AMARYLLIDACEAE
*Hypoxis hirsuta* (L.) Cov. [A *3819*, C]

ARACEAE
*Peltandra virginica* (L.) Schott [A *4035*]

BURMANNIACEAE
*Burmannia capitata* (Walt.) Mart. [A, C *3563*]

CYPERACEAE
*Carex atlantica* Bailey [A *3814*, C *3841*]
*Carex glaucescens* Ell. [C]
*Carex lurida* Wahlenb. [A *3815*, C *3842*]
*Carex stricta* Lam. [A *3813*, C *3770*]
*Cladium mariscoides* [A *3990*]
*Cladium mariscus* (L.) Pohl subsp. *jamaicense* (Crantz) Kukenth. [C *3993*]
*Cyperus odoratus* L. [C *3690*]
*Cyperus haspan* L. [C *3436*]
*Eleocharis equisetoides* (Ell.) Torr. [A *3952*, C *3961*]
*E. olivacea* Torr. [C *3708*]
*E. tortilis* (Link) Schultes [A *3802*, C *3846*]
*Fuirena squarrosa* Michx. [A *3602*, C *3434*]
*Rhynchospora cephalantha* A. Gray [C *3561*]
*R. chalarocephala* Fern. & Gale [A *3992*, C *3999-A*]
*R. corniculata* (Lam.) A. Gray [A *3981*, C]
*R. globularis* (Chapm.) Small [A *3834*, C]
*R. glomerata* (L.) Vahl [C *3411*]
*R. gracilenta* A. Gray [A *3595*, C]
*R. rariflora* (Michx.) Ell. [A *3832*, C]
*Scirpus cyperinus* (L.) Kunth [A, C *4026*]
*Scleria reticularis* Michx. [A *3599*, C *3558*]

ERIOCAULACEAE
*Eriocaulon decangulare* L. [A *3826*, C *3410*]
*E. kornickianum* van Heurck & Muell.-Arg. [A *3950*]

IRIDACEAE
*Iris virginica* L. [A *3821*, C *3849*]
*Sisyrinchium langloisii* E. Greene [A *3805*]

JUNCACEAE
*Juncus coriaceus* Mack. [C *3584*]
*J. diffusissimus* Buckl. [A, C *3972*]
*J. effusus* L. [A *3810*, C *3838*]
*J. marginatus* Rostk. [A *3833*, C *3996*]
*J. scirpoides* Lam. [A]
*J. trigonocarpus* Steud. [A *3603*, C *3568*]

LILIACEAE
*Zigadenus densus* (Desr.) Fern. [A *3820*]

MAYACACEAE
*Mayaca fluviatilis* Aubl. [A *3673*, C *3579*]

ORCHIDACEAE
*Calopogon tuberosus* (L.) B.S.P. [A, C *3974*]
*Platanthera ciliaris* (L.) Lindl. [C *3444*]
*Pogonia ophioglossoides* (L.) Ker.-Gawl. [A *3822*, C *3837*]
*Spiranthes cernua* (L.) L.C. Rich. [A *3682*, C *3684*]

POACEAE
*Agrostis hyemalis* (Walt.) B.S.P. [A *3801*]
*Agrostis scabra* Willd. [A *3741*, C *3697*]
*Andropogon glomeratus* (Walt.) B.S.P. [A *3600*, C *3555*]
*Chasmanthium laxum* (L.) Yates [C *3437*]
*Cinna arundinacea* L. [C *3583-B*]
*Coelorachis rugosa* (Nutt.) Nash [A *3681*]
*Dichanthelium dichotomum* (L.) Gould var. *dichotomum* [A, C *3839*]
*D. scabriusculum* (Ell.) Gould & Clark [A *3816*, C *3711*]
*D. scoparium* (Lam.) Gould [A *3975*, C]
*Erianthus giganteus* (Walt.) Muhl. [A *3596*, C *3550*]
*Leersia hexandra* Sw. [C *3696*]
*L. oryzoides* (L.) Sw. [C *3693*]
*Panicum rigidulum* Bosc. *ex* Nees [A *3601*, C *3553*]
*Panicum verrucosum* Muhl. [A, C *3673*]
*Panicum virgatum* L. [A, C *3593*]
*Paspalum plicatulum* Michx. [C *3582*]
*Paspalum praecox* Walt. [A *3678*]
*Sacciolepis striata* (L.) Nash [A]

SMILACACEAE
*Smilax glauca* Wall. [A, C]

SPARGANIACEAE
*Sparganium americanum* Nutt. [C *3995*]

XYRIDACEAE
*Xyris ambigua* Bey. *ex* Kunth [A, C *3401*]
*X. baldwiniana* Schultes [A *3951*, C *3962*]
*X. difformis* Chapm. var. *difformis* [A, C *3407*]
*X. jupicai* L.C. Rich. [C *3409*]
*X. torta* Sm. [A *3985*, C *3403*]

ACERACEAE
*Acer rubrum* L. [A, C *4028*]

APIACEAE
*Centella erecta* (L.*f.*) Fern. [A, C]
*Eryngium integrifolium* Walt. [A, C *3422*]
*Hydrocotyle umbellata* L. [A, C]
*Oxypolis rigidior* (L.) Raf. [C *3571*]
*Ptilimnium capillaceum* (Michx.) Raf. [A, C *3968*]
*P. costatum* (Ell.) Raf. [A, C *3412*]

ASCLEPIADACEAE
*Asclepias rubra* L. [A, C *3417*]

ASTERACEAE
*Aster lateriflorus* (L.) Britt. [A *3680*, C]
*A. puniceus* L. var. *scabricaulis* (Shinners) A.G. Jones [A *3672*, C *3710*]
*A. umbellatus* P. Mill. [C *3713*]
*Boltonia diffusa* Ell. [LR *3604*, C]
*Eupatorium fistulosum* Barratt [C]
*E. perfoliatum* L. [A, C]
*E. rotundifolium* L. [A, C *3415*]
*Helianthus angustifolius* L. [A, C *3548*]
*Liatris pycnostachya* Michx. [C]
*Mikania scandens* (L.) Willd. [C *3585*]
*Pluchea rosea* Godfrey [A, C]
*Solidago rugosa* P. Mill. [A 3598, C *3569*]
*Vernonia missurica* Raf. [A, C *3414*]

BETULACEAE
*Alnus serrulata* (Ait.) Willd. [A, C *4030*]

CAMPANULACEAE
*Lobelia puberula* Michx. [A *3597*, C *3572*]
*L. reverchonii* B.L. Turner [A *3683*, C *3704*]]

CAPRIFOLIACEAE
*Viburnum nudum* L. [A, C *3419*]

CLUSIACEAE
*Hypericum crux-andreae* (L.) Crantz [A *4036*, C]
*H. mutilum* L. [A, C *3441*]
*Triadenum virginicum* (L.) Raf. [A, C *3554*]

DROSERACEAE
*Drosera brevifolia* Pursh [A *3829*, C]
*D. capillaris* Poir. [A, C *3576*]

ERICACEAE
*Rhododendron oblongifolium* (Small) Millais [C *3973*]

FABACEAE
*Apios americana* Medic. [A]

GENTIANACEAE
*Bartonia paniculata* (Michx.) Muhl. [A *3679*, C *3688*]

HYDROPHYLLACEAE
*Hydrolea ovata* Choisy [A *4037*]

LAMIACEAE
*Lycopus rubellus* Moench [A, C *3586*]
*Scutellaria integrifolia* L. [A *3807*, C *3848*]

LENTIBULARIACEAE
*Utricularia cornuta* Michx. [A *3808*, C]
*U. gibba* L. [A, C *3580*]
*U. juncea* Vahl. [A 3988, C *3994*]
*U. subulata* L. [A 3828, C *3847*]

LINACEAE
*Linum striatum* Walt. [C *3424*]

MALVACEAE
*Hibiscus moscheutos* L. subsp. *lasiocarpus* (Cav.) O.J. Blanchard [A *3984*]

MELASTOMATACEAE
*Rhexia mariana* L. [A, C *3578*]
*R. virginica* L. [A, C *3565*]

MYRICACEAE
*Myrica cerifera* L. [A, C *3421*]

NYSSACEAE
*Nyssa sylvatica* Marsh. [A, C]

ONAGRACEAE
*Ludwigia alternifolia* L. [A *3980*, C *3566*]
*L. decurrens* Walt. [C *3687*]
*L. glandulosa* Walt. [A, C]

POLYGALACEAE
*Polygala cruciata* L. [A, C *3420*]
*P. sanguinea* L. [A *3954*, C]

RUBIACEAE
*Cephalanthus occidentalis* L. [C]

SALICACEAE
*Salix nigra* Marsh. [C]

SARRACENIACEAE
*Sarracenia alata* Wood. [A *3674*, C]

SAURURACEAE
*Saururus cernuus* L. [A, C *3425*]

SCROPHULARIACEAE
*Agalinis fasciculata* (Ell.) Raf. [A, C *3691*]
*Gratiola brevifolia* Raf. [A *3976*, C]

URTICACEAE
*Boehmeria cylindrica* (L.) Sw. [A, C *3559*]

VALERIANACEAE
*Valerianella woodsiana* (Torr. & Gray) Walp. [A *4034*]

VIOLACEAE
*Viola primulifolia* L. [A *3812*, C *3850*]
*V. missouriensis* E. Greene [C *3777*]

There were 105 species, 71 genera, and 42 families in Andrew's Bog. There were 118 species, 78 genera, and 42 families in Chester's Bog. Sorensen's Index of Similarity (Sorensen 1948) between them is 80, meaning that they are essentially identical floristically. Combining both lists, dicots account for 45% of the total. Monocots, ferns, and others account for 55% of species, which is typical of bog communities elsewhere. The vast majority of plant species at both study sites were hydrophytes (Reed 1988). The main families were Cyperaceae, Juncaceae, Poaceae, Xyridaceae, Apiaceae, and Asteraceae.

Steve Orzell and Edwin Bridges made extensive observations and collections on these bogs in 1988 and 1990. They have vouchers for a number of species that we did not find. In Table 2, we list these alphabetically and indicate which bog they came from. We did not include these collections in our list because they were made a decade ago and might not presently be at these sites and because we collected only in a specific portion of each bog. Orzell & Bridges' collection numbers are given, but their collections have yet to be deposited in an herbarium. Absence of a specimen number indicates that the taxon was not collected but only entered in field notes.

Table 2. Orzell & Bridges' additions to Chester's (C) and Andrew's (A) bog flora. Numbers refer to Bridges & Orzell collections.

*Aletris aurea* L. [A]
*Amorpha paniculata* Torrey & Gray [A *7961*]
*Carex longii* Mack. [A *13694*, C *13721*]
*Cirsium muticum* Michx. [A *7974*]
*Coreopsis tripteris* L. [A *7970*]
*Eleocharis quadrangulata* (Michx.) Roem. & Schult. [A *7958*]
*Ludwigia linearis* Walt. [A *7967*]
*L. sphaerocarpa* Ell. [A *7956*]
*Melanthium virginicum* L. [A]
*Mitreola sessilifolia* (Gmel.) G. Don [A *7952*]
*Panicum hemitomon* Schult. [A]
*Rhynchospora caduca* Ell. [A *7971*]
*R. stenophylla* Chapm. *ex* Curtis [A *7184*]
*Schizachyrium scoparium* [A *7959*]
*Scleria triglomerata* Michx. [C *13729*]
*Sorghastrum nutans* (L.) Nash [A]
*Thelypteris palustris* Schott [A *6590*]

*Xyris laxifolia* Mart. var. *iridifolia* (Chapm.) Kral [A]

Table 3 gives information on five soil samples from Chester's and Andrew's bogs. The "sand" samples were taken near the bog edge or margin, "med" was taken in the bog proper, and "deep" was taken about 35 cm below the surface in the bog proper.

Table 3. Soil chemistry of Chester's and Andrew's bogs. "Sand" samples were taken near the bog edge or margin; "med" was taken in the bog proper; and "deep" was taken about 35 cm below the surface in the bog proper.

| | | Exchangeable Ions (ppm) | | | | |
|---|---|---|---|---|---|---|
| Sample | pH | P | K | Ca | Mg | OM% |
| | | | | | | |
| Andrew's Sand | 4.6 | 7 | 41 | 200 | 46 | 3.4 |
| Andrew's Med | 4.7 | 17 | 47 | 427 | 77 | 4.8 |
| Andrew's Deep | 4.8 | 8 | 75 | 769 | 134 | 11.0 |
| Chester's Med | 4.3 | 8 | 18 | 126 | 29 | 3.5 |
| Chester's Deep | 4.8 | 13 | 69 | 1157 | 217 | 14.4 |

A more detailed analysis conducted on the Chester's Deep sample revealed the following dry basis: N = 1.71%, P = 0.035%, K = 0.29%, S = 0.53%, Mg = 0.21%, Ca = 0.59%, Na = 361 ppm, Fe = 5130 ppm, Al = 43200 ppm, Mn = 50 ppm, Cu < 0.01 ppm, Zn = 75 ppm. Organic matter, measured by combustion, was 50.4%. (Apparently the calorimetric method is accurate only for low organic content samples; consequently both Andrew's and Chester's bogs undoubtedly have high organic matter in the deep, muck/slurry areas.)

## DISCUSSION

Rowell (1949a, 1949b), Kral (1955), and Starbuck (1984) have developed checklists for muck bogs in the post oak savanna region. Rowell's study site was in Robertson County about 115 km SSW of our study site, and Kral's sites were in Van Zandt and Freestone counties about 57 km NNE and 50 km SSW, respectively, of our study sites. Starbuck (1984) studied several bogs in Robertson County about 100 km SSW of Anderson County. To make comparisons with our study sites, we modified some of these lists to exclude species that were obviously members of other associations.

Kral lists 80 species for his "Bog Edge" and "Bog Proper". Of these, 52 or 65% occurred in the bogs we studied. Rowell's (1949a) list is somewhat more problematic, but we found that of 68 species from his "zone two," which consisted of "low shrubs, grasses, and other herbaceous forms", 45 or 66% occurred at the two

Anderson County bogs. Starbuck (1984) lists 78 "bog species" of which we found 46 or 59% in Chester's and Andrew's bogs. Although these figures should be considered tentative since sampling methods among these studies differed, they nonetheless point to strong affinities among these different sites.

On the other hand, muck bogs show marked differences to pitcher plant bogs in deep east Texas and west Louisiana (Nixon & Ward 1986; Orzell 1990; MacRoberts & MacRoberts 1988, 1993), with a Sorensen's Index of Similarity of between 43 and 48.

Thus, while both hillside bogs and post oak savanna muck bogs have many species in common, for example, *Sarracenia alata* and *Eriocaulon decangulare*, many others are not shared. The post oak region is the western range limit of many bog species (e.g., *Sarracenia alata, Lycopodiella appressa, Burmannia capitata*, and *Eriocaulon decangulare*), and many other species drop out of the piney woods flora long before the post oak savanna region is reached (e.g., *Magnolia virginiana, Persea borbonia, Pinguicula pumila*, and *Rhexia lutea*). Also, because of habitat conditions, in the post oak savanna region, marsh species intermingle with bog species to create a unique association.

Classifications of Texas vegetation by region and by community fail to capture the nature of the muck bog plant associations or, for that matter, any of the inland marsh communities. Of all the wetland communities described by Correll & Correll (1972), inland marshes and bogs appear to be the most understudied. While the report "Preserving Texas' Natural Heritage" (LBJ 1978) describes "peat bogs and marshes" as distributed through the post oak savanna region, no further description is given and no information is provided about the relation between these two communities. Diamond *et al.* (1987) describe bogs as occurring in both the piney woods and the post oak savanna, but barely mention fresh water marshes except to say that they occur in "all regions" of Texas. The community list of the Texas Natural Heritage Program (1992) does no better; it barely mentions inland marshes, only indicating that *Juncus* is a dominant genus and that marshes occur throughout Texas. The Nature Conservancy classification of ecological communities of the southeastern United States (Weakley *et al.* 1998) does not describe Texas muck bogs: although many marsh communities that resemble Texas post oak savanna marshes are listed, no Texas sites are specifically mentioned.

Although our experience of wetland communities in the post oak savanna region of the WGCP is limited, at present we believe that, while there were few natural lakes, historically there were many marshes, hillside bogs, muck bogs, peatlands, and probably other kinds of marsh-bog herb-dominated wetlands. What we have described for the GEWMA sites appears to be an interdigitation or intermingling of hillside bog and marsh. This appears to be what Rowell (1949a), Kral (1955), and Lodwick (1975) have described. This intermingling would explain the very high biomass found by Lodwick (1975) when compared with bogs elsewhere (Allen *et al.* 1988).

In conclusion, bogs and marshes and the bog-marsh complex of the post oak savanna region of Texas need additional and detailed research and sampling before any understanding of the wetlands in this area will be gained. Especially important are floristic studies of those hillside bogs that do not grade into marshes, and studies of inland marshes in general.

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